https://doi.org/10.48047/AFJBS.6.14.2024.6323-6328

African Journal of Biological Sciences

Journal homepage: http://www.afjbs.com

Research Paper Open Access

Evaluation of Ventricular Arrhythmia in Children with Structurally Normal Heart

Gehan H. Ahmed[1], Rodina S. Mohamed[1], Osama M. Abd Alaziz[1], Rania M, Elkaffas[1], Noha H. El Din Behery[2], Shereen A. Elmallwany[*1]

1 Pediatric Department, Faculty of Medicine, Cairo University, Egypt.

2 Radiology Department, Faculty of Medicine, Cairo University, Egypt.

3 Pediatric Department, Elmenshawy Hospital, Ministry of Health and Population, Egypt.

Corresponding author: Shereen A. Elmallwany

Email: dr.shereenelmallwany@gmail.com

Article History

Volume 6, **Issue** 14, 2024

Received: 15 July 2024

Accepted: 19 August 2024

doi: 10.48047/AFJBS.6.14.2024.6323-6328

Abstract:

Background: Ventricular arrhythmia may be an isolated benign finding in children, a marker of serious systemic disease or myopathy or a mechanism for syncope and sudden cardiac death. Arrhythmogenic right ventricular dysplasia (ARVD) is an inherited cardiomyopathy disorder, leading to arrhythmias, and predominantly involving the right ventricular myocardium. Aim of the work: Evaluation of pediatric patients with ventricular arrhythmias for presence of systemic disease and detection of cardiac abnormalities that could not be detected by routine echocardiography using cardiac magnetic resonance imaging (CMR) in children with a structurally normal heart.

Materials and Methods: This Cross-sectional observational study was carried out on Twenty-one cases of ventricular arrhythmia with a structurally normal heart were included. We studied the clinical picture, 12 leads ECG with measurement of {QRS duration, QTc, QTc dispersion, JTc, JTc dispersion, T (p-e) and T (p-e)/QT}, 24 hours holter monitoring, echocardiography and CMR for selected cases.

Results: Palpitation was the presenting symptom in 66.6% of the cases and syncope in 23.8%. Ventricular arrhythmia were of right ventricular origin in 95.2% of the cases, polymorphic in 61.9%. QTc dispersion and JTc dispersion were statistically significant higher in cases with chest pain (P value 0.001). Holter detected ventricular arrhythmia frequency ranged from (4-47%). One case was diagnosed as Wilson disease. No cardiac abnormalities were detected in CMR. Medical management was indicated in 16 cases (76%).

Conclusion: Ventricular arrhythmia in structural normal heart is not common. Majority of ventricular arrhythmia were polymorphic. ARVD is not a common disease in pediatrics.

Keywords: Holter, PVCs, CMR, Ventricular arrhythmias, ARVD

1. Introduction

Ventricular arrhythmia could be classified into 3 diagnostic groups, depending on their complexity in ambulatory as well as in 12-lead electrocardiography. They represent a continuous spectrum ranging from the "benign" sporadic ventricular ectopic beats to the malignant ventricular arrhythmia, such as sustained ventricular tachycardia (VT) and ventricular fibrillation (VF). In between there is the group of potentially malignant arrhythmia, such as very frequent premature ventricular contractions (PVCs), ventricular couplets and episodes of non-sustained VT [1].
The evaluation of young patients with idiopathic ventricular arrhythmia, including physical exam for evidence of systemic disease (such as connective tissue diseases and thyroid abnormalities). ECG, Holter and echocardiographic characteristics, must be undertaken to exclude the presence of these recognized disorders (long QT syndrome, short QT syndrome, Brugada syndrome, catecholaminergic polymorphic VT (CPVT), ARVC, cardiomyopathy, etc.); if identified, disease-specific management can then be initiated [2]. Additional diagnostic evaluation such as cardiac magnetic resonance imaging (CMRI) may be indicated depending on individual patient factors. MRI can detect wall-motion abnormalities including right ventricular dyskinesia, a corrugated pattern to the right ventricular wall known as the "accordion sign". Cardiac MRI may be most important when assessing a patient for ARVC, as abnormal MRI findings constitute major criteria for the diagnosis of this disease. CMR may also be useful when the echocardiogram suggests or cannot exclude coronary anomalies or tumors [3]. The aim of this study is to evaluate pediatric patients with ventricular arrhythmia for presence of systemic disease and detection of cardiac abnormalities that could not be detected by routine echocardiography using CMR in children with a structurally normal heart.

2. Subjects and Methods:

This Cross-sectional observational study was conducted in Cairo University Children's hospital during the period from April 2017 to March 2020 after obtaining permission from institutional ethical committee and an informed consent was taken from all parent of patients. Inclusion criteria included: Children from 1 Day to 16 years of age of both sex with ventricular arrythmia proved by 12 leads ECG and/or 24 hours Holter monitoring. The exclusion criteria included: Children with structural heart diseases or cardiomyopathy detected by transthoracic color Doppler echocardiography and proved to be not due to arrhythmia.
History, clinical examination and laboratory investigations were conducted. All ECG recording was obtained using the same 12 lead device, while the patients were resting in supine position for 10 minutes. Patients were asked to avoid caffeinated beverages & other stimulants within 3 hours and strenuous exercise 24 hours prior to the study. Some small age children received sedative agent as chloral hydrate in a dose of 50 mg/kg orally, half an hour before ECG. And the following parameters were measured manually: HR, Rhythm, QRS duration, QT interval, The JT interval, QT dispersion, JT dispersion, Corrected QT (QTc), Corrected JT (JTc), The Peak to end interval of T wave T(p-e) and T(p-e)/ QTc ratio.
Type of ventricular arrhythmia and Origin of focus detected by Holter ECG and ECHO was performed after use of sedation with choloral hydrate when indicated by pediatric cardiologists who are experts in echocardiography. The examination consists of the segmental approach to describe all of the major cardiovascular structures in sequence. Evaluation included wall thickness

assessment, quantitation of systolic function, measurement of indices of diastolic function, and exclusion of valvular lesions, coronary artery anomalies, and cardiac tumors. Cardiac MRI was performed and interpreted by a radiologist. It was done to 12 case only as some parents refused to do CMR to their children. We used suitable techniques according to age of the patients. The changes required encompass the environment of the scanner suite, coil, sedations, faster heart rates, and reduced circulation times. Most commonly used CMR views: Short Axis, True Axial, two and four chambers views through Segmentation and synchronization to the cardiac cycle appear in Cine images.

Statistical analysis:

Statistical analysis was done by SPSS program, version 25 (IBM Inc., Chicago, IL, USA). Normality of data was checked with Shapiro-Wilks test and all variables were normally distributed. Quantitative variables were presented as mean, standard deviation (SD) and range and were compared between the two groups utilizing Student's t- test. Categorical variables were presented as frequency and percentage (%) and were analysed utilizing the Chi-square test or Fisher's exact test when appropriate. Pearson correlation was done to estimate the degree of correlation between two quantitative variables. P value < 0.05 was considered statistically significant.

3. Results

Over a period of 3 years, the total number of cases attending the pediatric arrhythmic clinic was 6570 cases. 21 cases were detected to have ventricular arrhythmia with structural normal heart. This represented 0.003% of the cases attending the arrhythmia clinic. As regards demographic data (age, and gender) and systemic diseases, the minimum age of the studied cases was 1 month, maximum was 14 years (168 months) with a median of 60 months, 13 (61.9%) were males and 8 (38.1%) were females and one case of systemic disease (Wilson disease) and ventricular arrhythmia. As regards the most common presenting symptom, it was palpitations (66.67% of the studied cases). Majority of the studied cases had ventricular focus of arrhythmia to be of right ventricular origin, 20 (95.24%). Figure (1).

As regards Majority of ventricular arrhythmia pattern was PVCS occurred in 17 (80.95% of cases), and minority was Triplet, which occurred in 2 (9.52% of cases). Majority was polymorphic Table (1). Also, No patients developed CMR abnormalities, CMR detected cardiac mass, WMA or myocardial fibrosis. Table (2).

There was a negative significant correlation between24 hours Holter detected ventricular arrhythmia frequency and both FS and EF measured by echocardiography ($r = -0.451$ and -0.449 respectively), ($P = 0.040$ and 0.041 respectively). There was a negative significant correlation between (QTc and CMR RV EF) and (T (p-e) and CMR RV EF). [($r = -0.597$, $P = 0.041$) and ($r = -0.607$, $P = 0.036$) respectively]. Figure (2). As regards QTc dispersion and JTc dispersion were significantly higher in patients with chest pain compared to patients without chest pain [$P = 0.001$].

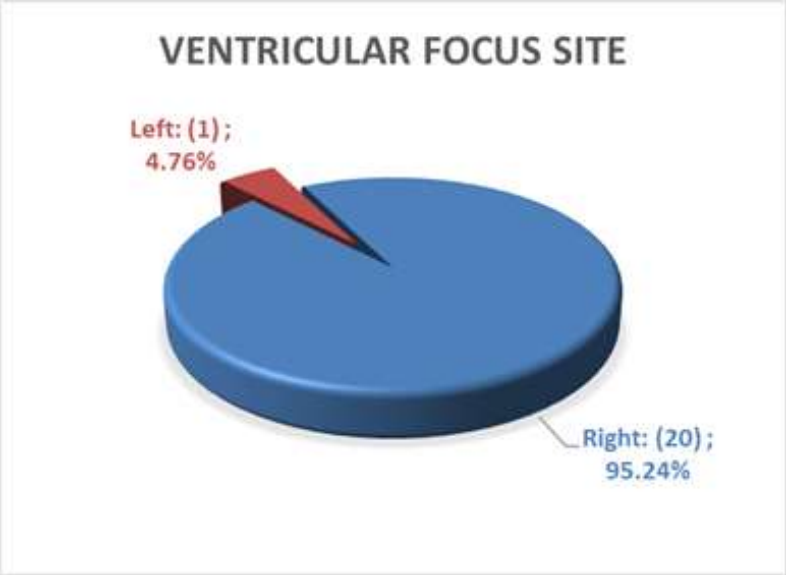


Figure (1): Ventricular focus site in the studied cases

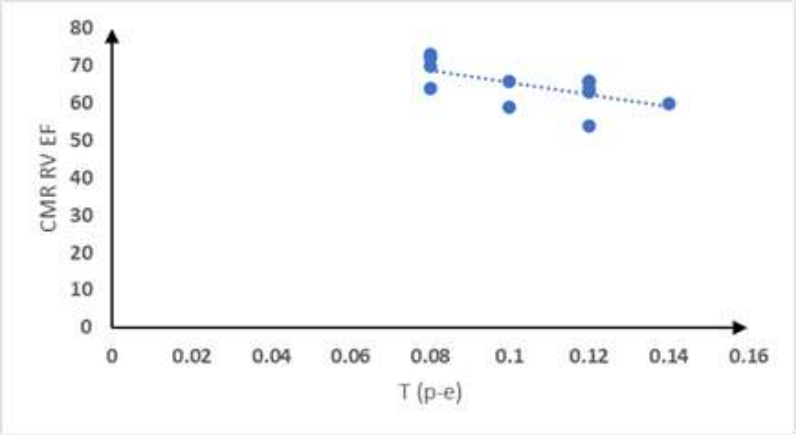
Table (1): Twenty four hours Holter monitoring findings of the studied cases

		Patients (n = 21)
Holter ventricular arrhythmia morphology (N°/%)	**Polymorphic**	13 (61.9%)
	Monomorphic	8 (38.1%)
Holter ventricular arrhythmia pattern (N°/%)	**PVCS**	17 (80.95%)
	Bigemini	8 (38.1%)
	Trigemini	5 (23.81%)
	Runs	6 (28.57%)
	Couplets	4 (19.05%)
	Triplet	2 (9.52%)

Table (2) : Cardiac Magnetic Resonance imaging (CMR) findings of the studied cases.

		Patients (n = 12)
CMR abnormalities (N°/%)		0 (0%)
LV EF(%)	**Mean ± SD**	65.17 ± 4.65
	Range	60-75
RV EF(%)	**Mean ± SD**	64.75 ± 5.46
	Range	54-73
RV EDVI (ml/m^2)	**Mean ± SD**	83.25 ± 22.56
	Range	56-135
Cardiac mass (N°/%)		0 (0%)
Wall motion abnormalities (N°/%)		0 (0%)
Myocardial fibrosis (N°/%)		0 (0%)

* LV EF(%) : (Left ventricular ejection fraction).
* RV EF(%) : (Right ventricular ejection fraction).
* RV EDVI (ml/m2) : (Right ventricular end diastolic volume index).



(r = -0.607, P = 0.036)

Figure (2): Correlation between T (p-e) and Cardiac Magnetic Resonance Right ventricle ejection fraction

4.Discussion

Premature ventricular contractions (PVCs) in a structurally normal heart generally are considered benign regardless of their frequency or age. Rarely, however, reversible cardiomyopathy may develop. Treatment usually has been recommended for sustained and fast non-sustained ventricular tachycardia. However, an evidence has been mounting regarding a possible role of frequent PVCs as a cause of left ventricular dysfunction [4]. This study evaluated twenty one pediatric patients of ventricular arrhythmia with a structurally normal heart. They represented 0.003% of those attending pediatric arrhythmia clinic. Being uncommon condition is supported by the study performed by Kakavand et al, (2010) who identified 28 patients with frequent PVCs in children with a structurally normal heart, (17 boys and 11 girls) [4]. In our study, the most common presenting symptom in children of ventricular arrhythmia with a structurally normal heart was palpitations, syncope and chest pain. This is contradictory to what was reported by other investigators. Niwano et al, (2009) reviewed 28 patients with frequent PVCs and reported orthostatic complaints and chest pain as accompanying symptoms but no patient reported any palpitations [5]. Kakavand et al, (2010) found that most children with frequent PVCs remain asymptomatic but the most common associated complaints in symptomatic patients were chest pain, dizziness, and vasovagal syncope. The current study demonstrated that majority of the studied cases had ventricular focus of arrhythmia to be of right ventricular origin, 20 (95.24%). This in agreement with, Kakavand et al, (2010) who found that the focus of the ectopic beats in the majority of the patients was in the right ventricle for both genders. In our study, we found that Holter detected ventricular arrhythmia frequency ranged from 4-47% with a median value 11[4]. This is slightly higher range than that reported by Kakavand and his colleagues who found in their study that the average of ventricular arrhythmia frequency on a 24-h Holter monitor at the time of the diagnosis was 5-35 %. [4].

In our study, we found that majority of ventricular arrhythmia pattern was isolated PVCS occurred in 17 (80.95% of cases) in Holter monitoring. This is coinciding with the results of previous investigators in a similar study who reported high burden of PVCs [6]

In our study, we demonstrated normal ECG parameters that represent ventricular contraction and repolarization in all cases in the study (QRS, QTc, JTc, JT dispersion, T (p-e) or T (p-e)/QT). This is in agreement with earlier study that could not demonstrate abnormal QT or JT dispersion in children with idiopathic ventricular arrhythmia with structurally normal hearts [7]. It was reported

that prolonged T-peak-to-T-end interval was associated with the development of ventricular tachycardia in high-risk patients with organic heart disease [8]. The T-peak-to-T-end to QT interval ratio has been shown to be an electrocardiographic indicator of arrhythmo-genesis for both congenital and acquired ion channel diseases that lead to ventricular arrhythmia [9].

We reported two cases with ventricular arrhythmia and secondary dilated cardiomyopathy who improved on medical management. They had PVCs in the form of couplets, triplets and runs of VT. Kakavand and his colleagues reported absence of cardiac dysfunction in pediatric patients with frequent PVCs [4]. This in agreement with, Niwano et al, (2009) found a statistically significant decrease in LV ejection fraction and a statistically significant increase in LV diastolic dimension in adult patients with frequent PVCs [5].

We did not found cases with criteria of ARVD/C in CMR may be due to the mean age of our cases was 6 years but pediatric ARVD/C is primarily a disease of adolescence and pediatric-onset ARVD/C occurred in about one-sixth of the overall ARVD/C population.as was found in other studies. Bauce et al, (2011), who found that pediatric patients with ARVD/C had a mean age at diagnosis of 15 ± 2 years[10]. Anneline et al, (2015) found that the mean age of children in his study was 15 years, and the youngest patient with a definite ARVD/C diagnosis was 11 years of age. The difference between our results and that of other investigations as regard ARVD/C could be attributed to ethnical or genetic factors indicating that this disease is not prevalent in Egypt. Also, it could be explained by what was reported by Anneline and his colleagues who reported that these cases often present by sudden cardiac death [6]. We reported a case of Wilson's disease with syncope and frequent polymorphic PVCs and frequent unsustained VT. In an Indian study, sinus tachycardia was the most common ECG abnormality reported in 50 cases of Wilson's disease, premature ventricular contraction reported in one case and none of the studied cases had syncope or VT [11].

Our results are contradictory to that of previous investigators who reported absence of serious potentially life-threatening ventricular arrhythmia in 51pediatric patients with Wilson’s disease [12]. We recommend that usage of 12 lead ECG and 24 hours Holter monitoring are gold standard in the diagnosis of ventricular arrhythmia and CMRI should not be a routine investigation for cases of ventricular arrhythmia with structural normal heart.

5. Conclusion

Ventricular arrhythmia in structural normal heart is not common. Palpitation is the most common symptom in children with ventricular arrhythmia with a structurally normal heart. Majority of ventricular arrhythmia were polymorphic. ECG, 24 hours Holter and Echocardiography are the most important methods for evaluation of ventricular arrhythmia in children. ARVD is not a common disease in pediatrics.

Financial support and sponsorship: Nil

Conflict of Interest: Nil

5. References

1. Gatzoulis KA, Archontakis S, Dilaveris P, Tsiachris D, Arsenos P, Sideris S, et al. (2011): Ventricular arrhythmias: from the electrophysiology laboratory to clinical practice. Part I: malignant ventricular arrhythmias. Hellenic J Cardiol 52: 525-35.
2. Crosson JE, Callans DJ, Bradley DJ, Dubin A, Epstein M, Etheridge S, et al. (2014): PACES/HRS expert consensus statement on the evaluation and management of ventricular arrhythmias in the child with a structurally normal heart. Heart Rhythm 11: e55-e78.
3. Tikkanen JT, Anttonen O, Junttila MJ, Aro AL, Kerola T, Rissanen HA, et al. (2009): Long-term outcome associated with early repolarization on electrocardiography. New England Journal of Medicine 361: 2529-37.
4. Kakavand B, Ballard HO, Disessa TG (2010): Frequent ventricular premature beats in children with a structurally normal heart: a cause for reversible left ventricular dysfunction? Pediatric cardiology 31: 986-90.
5. Niwano S, Wakisaka Y, Niwano H, Fukaya H, Kurokawa S, Kiryu M, et al. (2009): Prognostic significance of frequent premature ventricular contractions originating from the ventricular outflow tract in patients with normal left ventricular function. Heart 95: 1230-7.
6. Te Riele AS, James CA, Sawant AC, Bhonsale A, Groeneweg JA, Mast TP, et al. (2015): Arrhythmogenic right ventricular dysplasia/cardiomyopathy in the pediatric population: clinical characterization and comparison with adult-onset disease. JACC: Clinical Electrophysiology 1: 551-60.
7. WALLER III BR, Balaji S, Ye X, Gillette PC (1999): QT dispersion in children with ventricular arrhythmia and a structurally normal heart. Pacing clinical electrophysiology 22: 335-8.
8. Hevia JC, Antzelevitch C, Bárzaga FT, Sánchez MD, Balea FD, Molina RZ, et al. (2006): Tpeak-Tend and Tpeak-Tend dispersion as risk factors for ventricular tachycardia/ventricular fibrillation in patients with the Brugada syndrome. the American College of Cardiology 47: 1828-34.
9. Amoozgar H, Hosseiniasl M (2012): T-Peak to T-End abnormality in pediatric patients with syncope. Iranian journal of pediatrics 22: 385.
10. Bauce B, Rampazzo A, Basso C, Mazzotti E, Rigato I, Steriotis A, et al. (2011): Clinical phenotype and diagnosis of arrhythmogenic right ventricular cardiomyopathy in pediatric patients carrying desmosomal gene mutations. Heart Rhythm 8: 1686-95.
11. Meenakshi-Sundaram S, Sinha S, Rao M, Prashanth LK, Arunodaya GR, Rao S, et al. (2004): Cardiac involvement in Wilson's disease--an electrocardiographic observation. J Assoc Physicians India 52: 294-6.
12. Hamdani SSB, Cheema H, Saeed A, Malik HS, Sehar T (2018): Electrocardiographic Manifestations in Paediatric Wilson Disease. JAMC 30: 22-5.